KUBRICKY CONSTRUCTION CORP.
269 BALLARD ROAD

WILTON, NY 12831
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KUBRICKY CONSTRUCTION CORP.
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Issued 04/14/16

Rutland City BRF 3000 (2014036)
SUBMITTAL 86.0

To

Timothy Pockette, PE

Topic	BRF3000 Subm 86 (19) BR17 Dynamic Pile Load Test Abutment 2
Status	For Approval
Spec section	505.45
Subsection	(19)Ripley

Message

Tim,
Please find attached PDA for Ripley Abutment 2. This is also uploaded to sharepoint.

Thanks,
Mike

Courtesy Copy

Volker H.D. Burkowski

From

MICHAEL MARTIN

Signed by Michael C. Martin Date 4/14/2016

Proceed as Indicated ______________________ Date ______________
Owner Authorized Representative

GEOSCIENCES TESTING AND RESEARCH, INC.

55 Middlesex Street, Suite 225, N. Chelmsford, MA 01863
Ph: (978)251-9395, Fx: (978)251-9396

April 14, 2016 GTR Project # 14.227

Mr. Mike Martin
Project Engineer
Kubricky Construction Corp.
269 Ballard Road
Wilton, NY 12831

RE: Dynamic Pile Testing Report – Pile #22 – Abutment 2
Bridge Replacement Rutland City – BRF 3000 – Bridge 19
Rutland, Vermont

Dear Mike:

At your request, we were on site on April 6 and 11, 2016 to perform dynamic testing. The dynamic testing was requested in order to evaluate pile capacity, driving stresses, and hammer performance during test pile installation. Testing was conducted using the Pile Driving Analyzer^{TM} (PDA), which records, digitizes, and processes the force and acceleration signals for use in the Case Method and CAPWAP analyses. The dynamic testing was carried out in general accordance with ASTM D4945, “Standard Test Method for High Strain Dynamic Testing of Piles”.

Background and Site Description

A bridge replacement is proposed to be constructed in Rutland, Vermont. H-piles are planned for the support of the structure. One HP14x102 test pile was installed and tested in Abutment 2. Pile #22 was tested during the end of driving (EOD) on April 6, 2016 and tested during the beginning of restrike (BOR) on April 11, 2016.

Field Details

Subsurface Conditions

The generalized subsurface conditions at the abutments and pier consist of granular soil varying from silty sand to sandy gravel overlying bedrock. The soil is primarily medium dense and becomes very dense over the lower depths. Boulders and cobbles were frequently encountered within the granular soil. Bedrock was encountered at elevations ranging from +453 feet to +459 feet. For a more detailed description of the subsurface conditions, refer to the Geotechnical Report and/or the boring logs.

Pile Details

One steel HP14x102 H-pile was tested. The total pile length was 50 feet. The factored axial load was reported to be 174 kips. Based on AASHTO LRFD Bridge Design Specifications, the resistance factor is 0.65 (dynamic load testing) and the required nominal resistance is 268 kips. The cross-sectional area of the piles is 30.0 in^2. The maximum allowable compressive and tensile driving stresses are 45 ksi, based on AASHTO guidelines of 90% of the reported minimum yield strength of 50 ksi. A reinforced point was attached to the tip of the pile.

Driving System

An ICE 60S single acting diesel hammer was used to drive the piles. The maximum continuous rated energy for the hammer is 60 kip-ft (based on a ram weight of 7 kips and a stroke 8.6 feet). The over-stroke and maximum rated energy is 10.2 feet and 71.4 kip-ft, respectively. The cushion material, as reported by the manufacturer, is a Nylon and Aluminum, with an elastic modulus of 175 ksi, thickness of 2 inches, and coefficient of restitution of 0.92. The hammer cushion area is 491 square inches. The helmet weight (including anvil and insert) is 2.44 kips.

Instrumentation

The instrumentation consists of two strain gages and two accelerometer transducers attached around 3 feet below the pile top. One strain gage and one accelerometer were placed on opposite sides of the pile to minimize the effects of uneven impact and pile bending. This instrumentation provides information about driving stresses (compressive and tensile) and pile integrity, hammer performance (transferred energy), and pile bearing capacity.

The PDA is a computer fitted with a data acquisition and signal conditioning system. During driving, the strain and acceleration signals are recorded and processed for each hammer blow. The strain signal is converted to a force record and the acceleration signal is converted to a velocity record. The PDA saves selected hammer blows containing this information to disk and determines the compressive stresses, displacement, and energy at the point of measurement (pile top). In addition, the pile bearing capacity can be estimated in the field using the Case Method. This information can be viewed on the computer screen during driving. Selected blows can be further processed to predict the static pile capacity using the CAPWAP analysis. Refer to Appendix A for literature on the dynamic testing, the Case Method, and CAPWAP.

Results

General

The results of the dynamic testing program are summarized in Table 1, which include the driven depth, blow count, stroke, maximum transferred energy, maximum pile top displacement, and maximum compressive stress at the gage location and pile tip. The blow count was recorded by others.

Also included in Table 1 is the pile bearing capacity as determined by the Case Method in the field and CAPWAP analysis in the office. Three separate PDA plots of various parameters (maximum transferred energy and stroke - left plot, RMX Case Method capacity with Jc=0.5 and Jc=0.7 - middle plot, and maximum measured compressive stress at the pile top and max estimated compressive stress at the pile tip - right plot) are presented for the test pile with depth in Appendix B. Appendix B also contains the above data, and additional data, in tabular form.

In Table 1, the Case Method capacity represents an average over the blows or blow indicated for end of driving (EOD) or the beginning of restrike (BOR). A CAPWAP analysis was performed on a selected blow from EOD and BOR data. Appendix C contains the full results of the CAPWAP analysis and Table 2 summarizes the CAPWAP results.

Field Observations and Hammer Performance

The dynamic testing gages were attached to the pile and driven to around 33 feet below grade at around 30 blows per foot. The hammer was operated at a pump fuel pressure of around 400 psi resulting in a stroke of around 7 feet (corresponding to an averaged transferred energy around 20 kip-ft). The pile was then driven an additional 7 feet in an attempt to reach the required minimum embedment in the contract drawings. The blow count increased to 7 blows per inch (bpi) at that point. The hammer was operated at a pump fuel pressure of around 400 psi resulting in a stroke of around 7.5 feet (corresponding to an averaged transferred energy around 22 kip-ft) during the overdrive. Restrike testing to assess time dependent changes in pile capacity was performed 5 days after EOD.

Pile Integrity and Stresses

The maximum compressive and tensile driving stresses were below the allowable limit (45 ksi) throughout testing. The pile cap should be positioned directly over the pile axial center of gravity to maintain good hammer alignment during driving. This minimizes bending stresses and keeps local stress concentrations to a minimum. There were no signs of damage or significant misalignment between the pile and hammer during testing.

Pile Bearing Capacity

The Case Method field capacity (using the RX7 relationship) was around 430 kips to 650 kips during EOD at blow counts ranging from around 3 bpi to 7 bpi, respectfully. The CAPWAP capacity on a selected EOD blow was 400 kips (within the 30 bpf range) and 620 kips at BOR. Table 2 presents the results of the CAPWAP analyses in more detail. The total capacity, frictional capacity, end bearing capacity, and percentage of end bearing are included. The quake and damping soil parameters as determined from the CAPWAP analyses are also presented in Table 2.

Conclusions

The presented data from the dynamic measurements and their analyses leads to the following findings and conclusions.

1. For the test pile (#22) in Abutment 2, a CAPWAP capacity of 400 kips was obtained at 33 feet below grade. The pile was driven to around 30 bpf at this depth. The ICE I60s hammer was operated at pump fuel pressure of around 400 psi, resulting in a stroke of around 7 to 7.5 feet (20 to 22 kip-ft average transferred energy) during EOD.

2. Based on the CAPWAP analysis, around 75% to 80% of the pile capacity was developed in end bearing.

3. The maximum compressive and tensile driving stresses were below the allowable limit during testing. The dynamic records did not indicate pile damage.

4. We recommend a driving criterion of 3 blows per inch for 3 consecutive inches for the remaining piles. The piles should also achieve the minimum tip elevation as specified in the contract drawings. The hammer should be operated at a stroke of around 7 to 7.5 feet and transferred energy of 20 to 22 kip-ft).

Static pile capacity evaluations determined from dynamic testing provide an estimate of the axial pile bearing capacity at the time of testing. At very high blow counts (low pile set), the Case Method and CAPWAP analyses tend to predict lower capacities, since not all of the soil resistance may be fully mobilized, particularly at the pile toe. Other factors not considered in this analysis are time dependent changes in pile capacity (setup and/or relaxation), bending, downdrag, lateral and uplift requirements, cyclic loading, effective stress changes (e.g. due to changes in the water table, excavations, and/or fills), settlement, and pile group effects. The foundation designer should evaluate if any of these issues are applicable to the pile design.

This report has been prepared in accordance with generally accepted geotechnical engineering principles with specific application to this project. Our conclusions are based on applicable standards of practice, including any information reported to and/or prepared for us. No other warranty, expressed or implied, is made. If you have any questions regarding this report, please do not hesitate to contact us.

Sincerely,
Geosciences Testing and Research, Inc.

Mark Saunders

Mark C. Saunders
Project Engineer

Curtis A. George

Curtis A. George, P.E.
Senior Project Manager

Attachments: Tables 1 and 2, Appendices A through C
14.227 Rutland City Bridge 19 Abut 2 - PDA Report

TABLES

TABLE 1
SUMMARY OF DYNAMIC TESTING
PROPOSED BRIDGE REPLACEMENT RUTLAND CITY BRF 3000 (19)
RUTLAND, VT
HP14x102 H-PILES ICE I-60S OPEN-ENDED DIESEL HAMMER

Test Pile	Date	Time of[1] Driving	Driven[2] Depth (feet)	Observed Blow Count (blows/inch)	Blow Number(s)	Stroke [3] (feet)	Maximum [3] Transferred Energy (kip-ft)	Maximum [3] Displacement (inches)	Maximum [3] Comp. Stress Pile Top (ksi)	Maximum [4] Comp. Stress Pile Tip (ksi)	Case [5] Method Capacity (kips)	CAPWAP Capacity (kips)
Abutment 2 Pile #22	4/6/2016	EOD	~33	30 bpf	237-265	7.0	20.4	0.64	25.7	14.9	429	400
			~40	~ 7 bpi	492-573	7.5	21.7	0.52	27.4	23.8	652	-
	4/11/2016	BOR		6,5,4,5	6	9.3	30.0	0.65	30.6	21.1	563	620

Notes:

1. Indicates that the data was obtained during driving or during the end of driving (EOD) or the begining of restrike (BOR).
2. Depth is referenced from grade next to pile.
3. The stroke, maximum transferred energy, maximum pile top displacement, and maximum pile top compressive stress are determined by the PDA at the gage locations. These values represent an average over the blow(s) indicated.
4. The maximum compressive stress at the pile tip is estimated by the PDA. These values represent an average over the blow(s) indicated.
5. The Case Method capacity was determined using the RMX method and a JC value of 0.7. These values represent an average over the blow(s) indicated.

TABLE 2
SUMMARY OF CAPWAP RESULTS
PROPOSED BRIDGE REPLACEMENT RUTLAND CITY BRF 3000 (16)
RUTLAND, VT
HP14x102 H-PILES ICE I-60S OPEN-ENDED DIESEL HAMMER

Test Pile	Time of Driving	Blow Number				Percent End Bearing	Quake		Damping	
			Side	Tip	Total		Side (inch)	Tip (inch)	Side (sec/ft)	Tip (sec/ft)
Abutment 2 Pile #22	EOD	258	85	315	400	79%	0.10	0.50	0.15	0.06
	BOR	6	170	450	620	73%	0.06	0.37	0.15	0.05

APPENDIX A
DYNAMIC ANALYSIS LITERATURE

HIGH STRAIN DYNAMIC PILE TESTING

Introduction

Dynamic pile testing (a.k.a. High Strain Dynamic Pile Testing - HSDPT) is commonly employed for evaluating the capacity of driven piles. It is also provides information about hammer performance and pile integrity/stresses. Dynamic testing is carried out in accordance with ASTM D4945, “Standard Test Method for High Strain Dynamic Testing of Piles”. Dynamic pile testing involves using strain gages and accelerometers to record an impact wave and its reflections generated by a piling hammer. Both driven piles and drilled foundations can be tested (provided that an impact hammer is used to create the high strain wave for the drilled foundations).

Procedure

Dynamic pile testing was performed using a Pile Driving Analyzer (PDA®), such as the PAK®, PAL®, or PAX® systems, manufactured by Pile Dynamics, Inc. (PDI) of Cleveland, Ohio. These systems are computers fitted with data acquisition and signal conditioning components. The instrumentation consists of two strain gages and two accelerometer transducers attached a minimum of 1.5 pile diameters below the pile top. During impact, the strain and acceleration signals are recorded and processed for each hammer blow. The strain signal is converted to a force record and the acceleration signal is converted to a velocity record. The PDA® saves selected hammer blows containing this information to disk and determines the transferred energy, compressive/tensile stresses, displacement, pile integrity, and the estimated pile bearing capacity using the Case Method. This information can be viewed on the computer screen during driving. A screen shot of data collection in the PDA® Windows (PDA-W®) Program is provided in Figure 1. Selected blows can be further processed to predict the static pile capacity using signal matching programs.

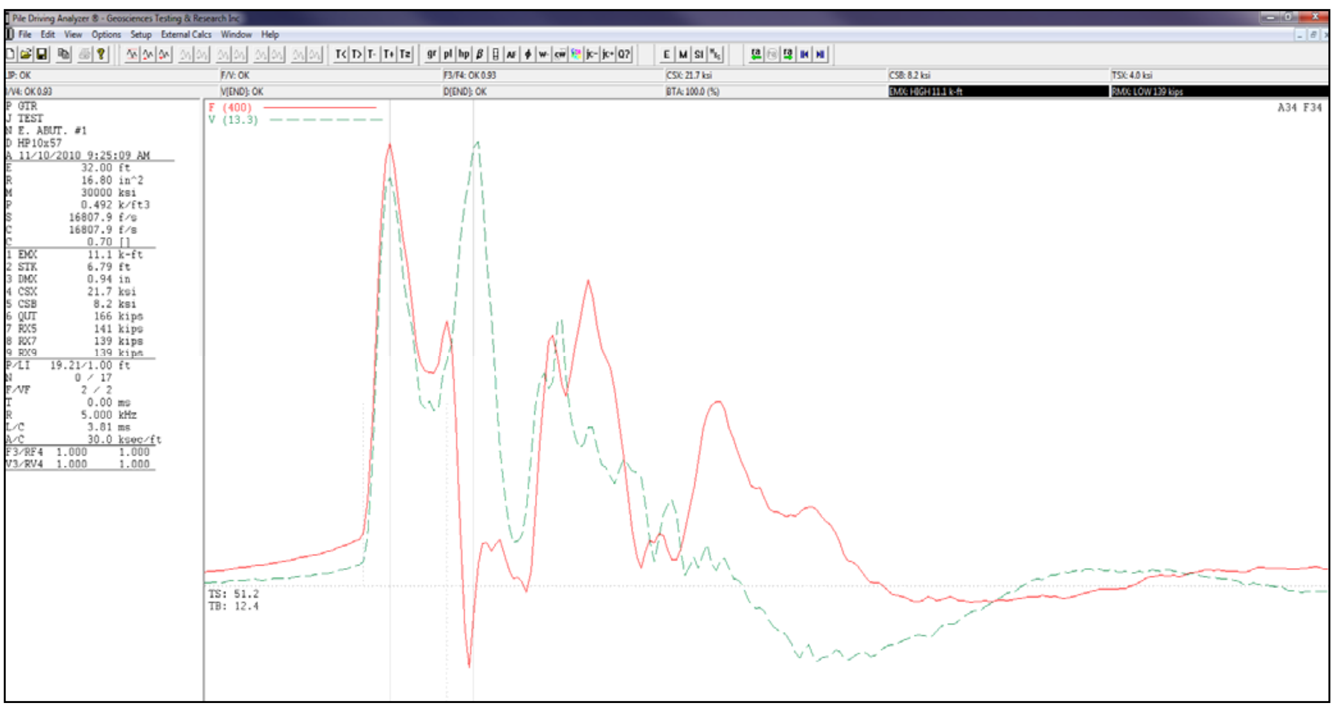


Figure 1. Data collection during pile driving in the (PDI - PDA®-Win Program).

Theory

When a ram strikes the pile head, it initiates a large strain wave that propagates down the pile as illustrated in Figure 2. External soil resistance or changes in the pile's impedance (due to variations in the pile's material or geometry) causes reflection waves that are recorded by the instrumentation. Knowing the material properties and pile geometry at the point of measurement, the strain can be converted to force, while the acceleration is integrated with time to produce velocity.

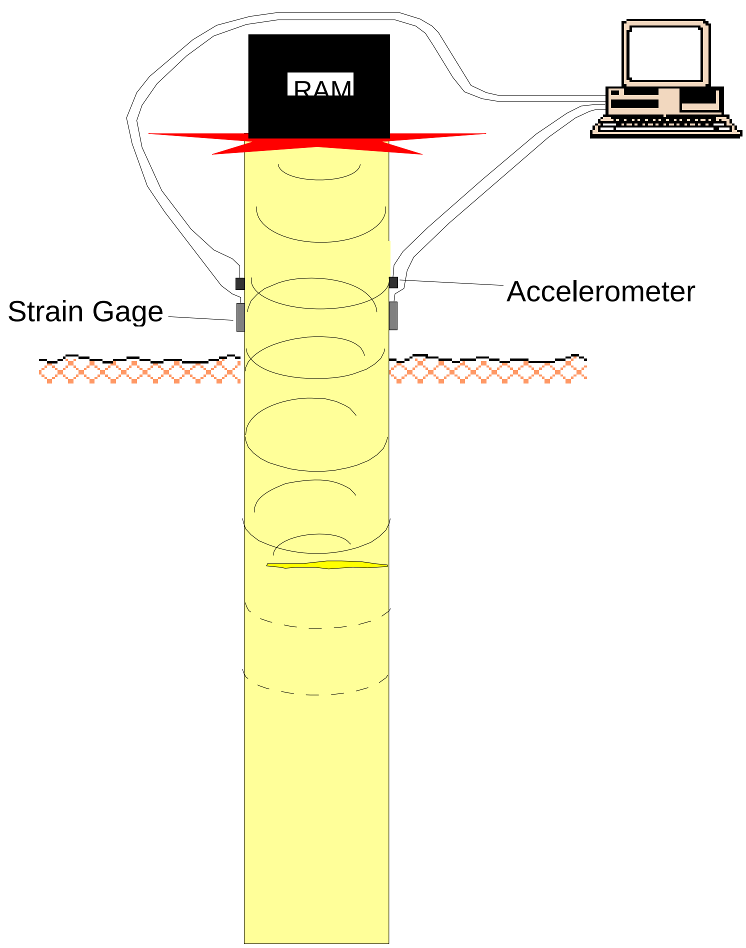


Figure 2. Pile instrumentation and hammer impact.

As long as there is no change in the pile impedance and there are no external forces (i.e. friction), the force and velocity are proportional (equal). Reflections at the tip can be explained by two classical boundary conditions. Free end conditions (analogous to easy driving through soft clay) require zero force and no velocity restrictions at the tip, resulting in a compression wave returning as a tension wave and an increase in velocity (theoretically doubling). Figure 3 graphically presents a typical reflection from a pipe pile during penetration into soft clay. Fixed end conditions (analogous to hard driving into bedrock) require zero velocity and no force restrictions at the tip, resulting in a compression wave being reflected with a greater magnitude than the incident wave (theoretically doubling) and the tip velocity at theoretically zero. Figure 4 graphically presents a typical reflection from an H-pile driven to bedrock. The time the wave takes to travel down to the tip and reflect back to the transducers is twice the pile length divided by the wave speed of the pile material (2L/C).

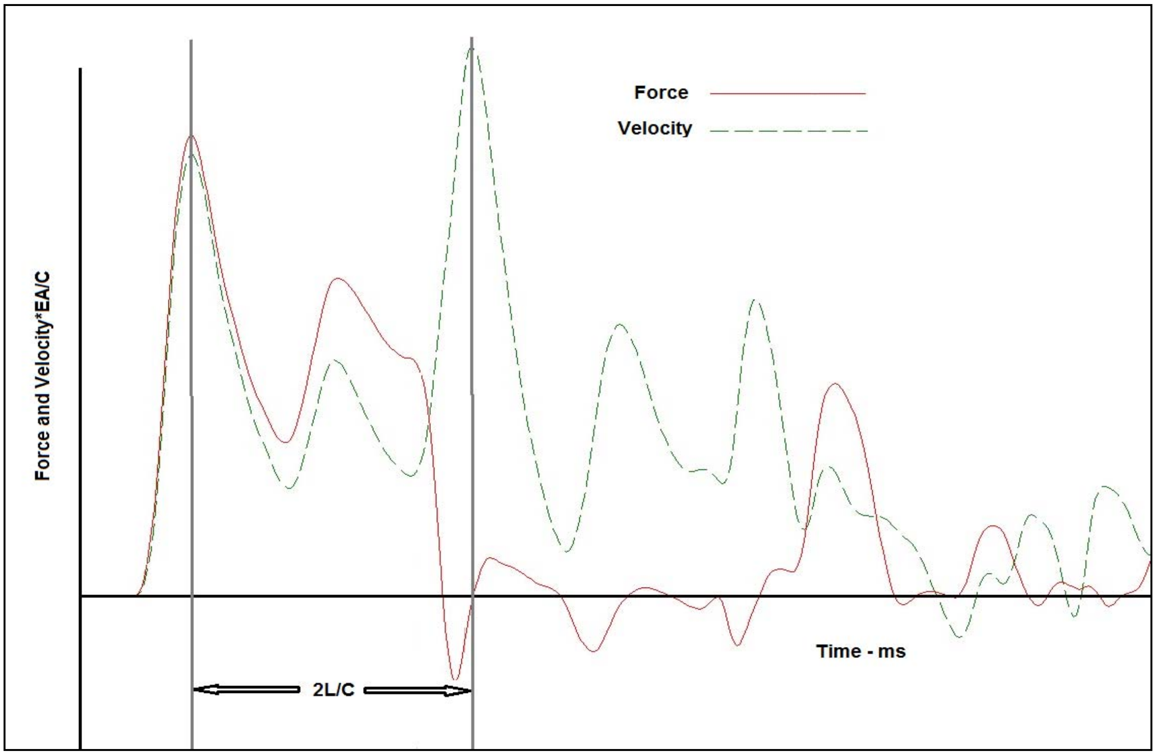


Figure 3. Typical Force and Velocity traces for a pipe pile driven into soft clay (high velocity and low force at tip - 2L/C).

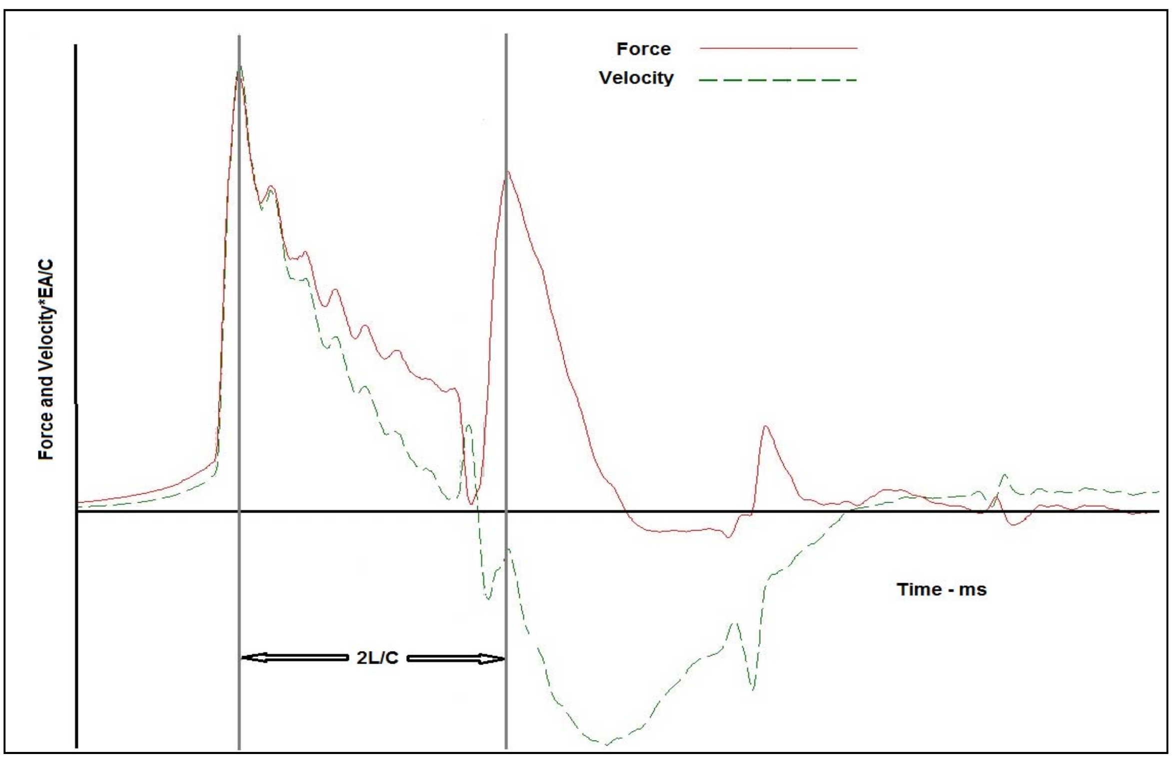


Figure 4. Typical Force and Velocity traces for an H-pile driven into bedrock (high force and low velocity at tip - 2L/C).

If a pile contains a defect or is damaged (e.g. reduction in impedance) during driving, the wave reflecting from the zone of decreased impedance will show a reduction in the force and increase in the velocity (somewhat comparable to "free end conditions"). These reflections would arrive to the measuring transducers before the expected reflections associated with the pile tip as the damaged zone is at a point along the pile between the transducer location and pile tip. The detection of damage during driving is usually easily identifiable and typically associated with cracking of concrete piles or splice breakage.

Dynamic Testing Summary Output

After data collection, the most pertinent output quantities from the dynamic pile testing can be summarized in a graphical manner. The data can be also presented in tabular format, averaging the results based on penetration depth or blow number as specified by the user. Figure 5 shows typical graphical output. Each of the three plots presents two quantities sharing the vertical (penetration) axis.

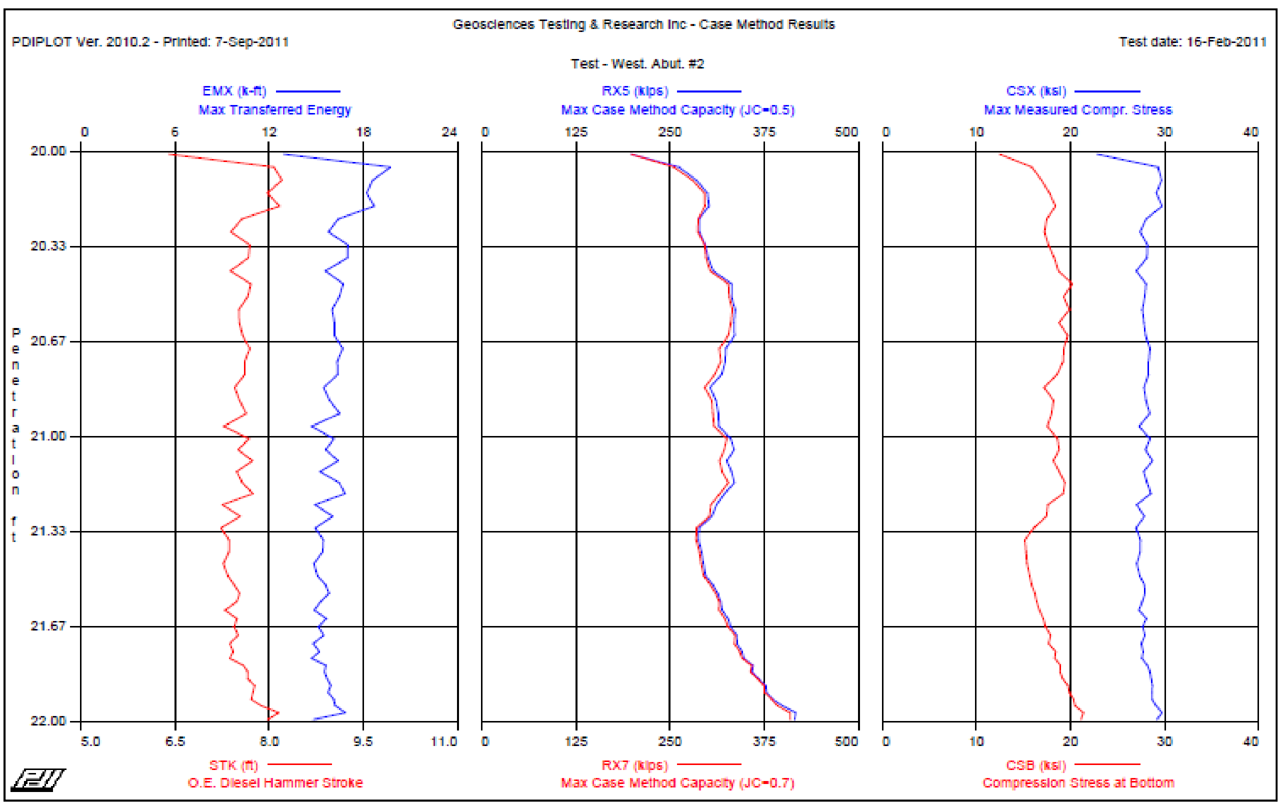


Figure 5. Typical Dynamic Testing summary Output (PDI Plot® Program)

Signal Matching Analyses

Signal matching using the dynamic testing data can be performed to predict the static pile capacity. Programs such as CAPWAP® (developed by Pile Dynamics, Inc.) or TEPWAP/PWAP (developed by GTR) are numerical analyses used to solve the one dimensional wave equation using the measured force and velocity. E.A Smith (1960) suggested modeling the hammer-pile-soil system for use in the wave equation by a series of masses, springs and dashpots as shown in Figure 6. The signal matching programs determine the best match between measured and calculated pile top forces and replace the hammer input with the measured force and velocity. The pile is separated into many small segments, often 1 meter in length. The velocity record obtained from the dynamic pile testing transducers is used as input to the top pile segment. The resistance, damping, and quake are the primary soil parameters assigned by the user to each pile segment below grade. The signal matching programs will calculate the displacement, velocity, and stresses (forces) for each pile segment based on the input velocity record and the user assigned soil parameters. These parameters are adjusted and modified in an iterative fashion until the best match is obtained between the force calculated for the pile top segment and the force measured at the pile top during testing. The user assigned soil parameters based on the best match represent the "actual soil conditions", including the resistance (and therefore pile capacity). This capacity is based on the resistance at the time of the testing. Static load tests are typically conducted several days or weeks after driving. Therefore, restrike tests are recommended to be performed some time after driving to assess time dependent changes in pile capacity, such as setup or relaxation.

New PDA Appendix.docx

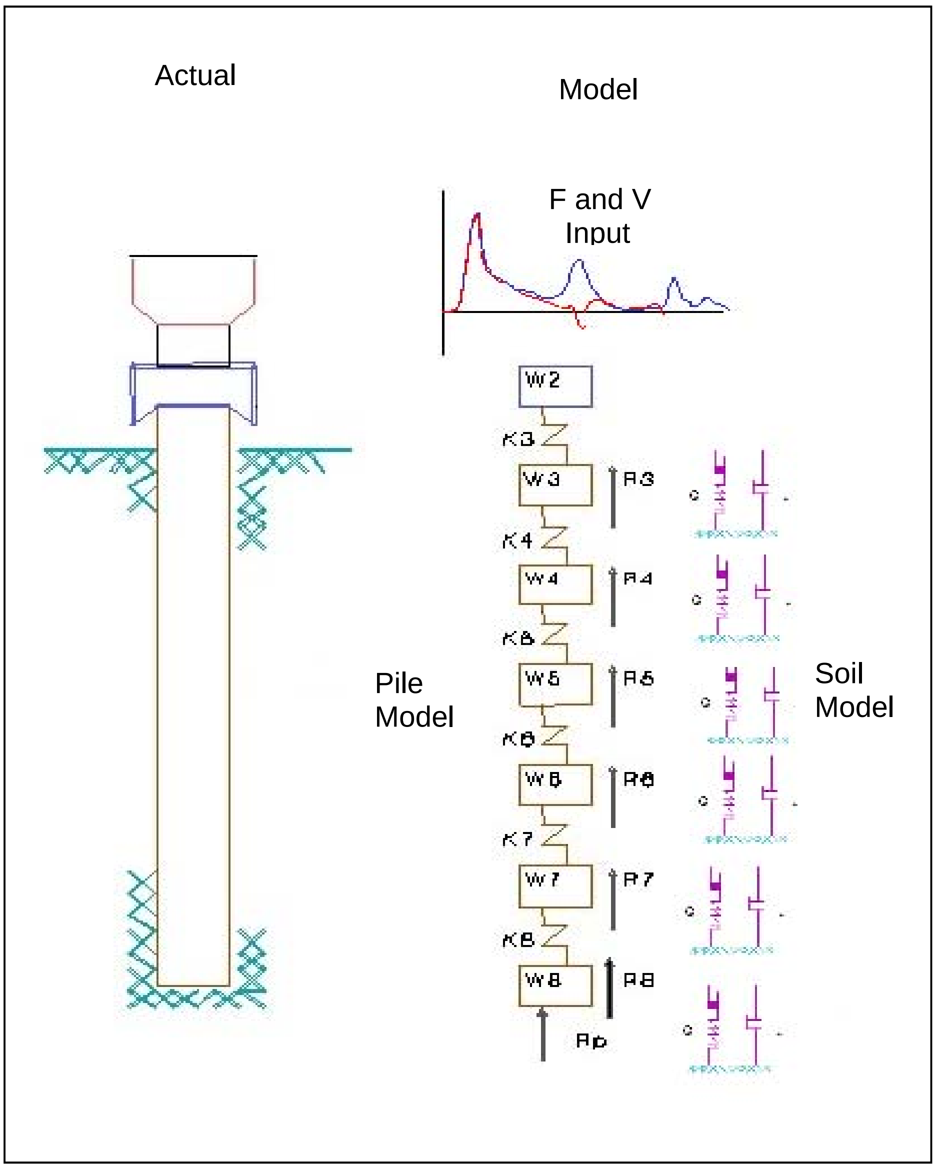


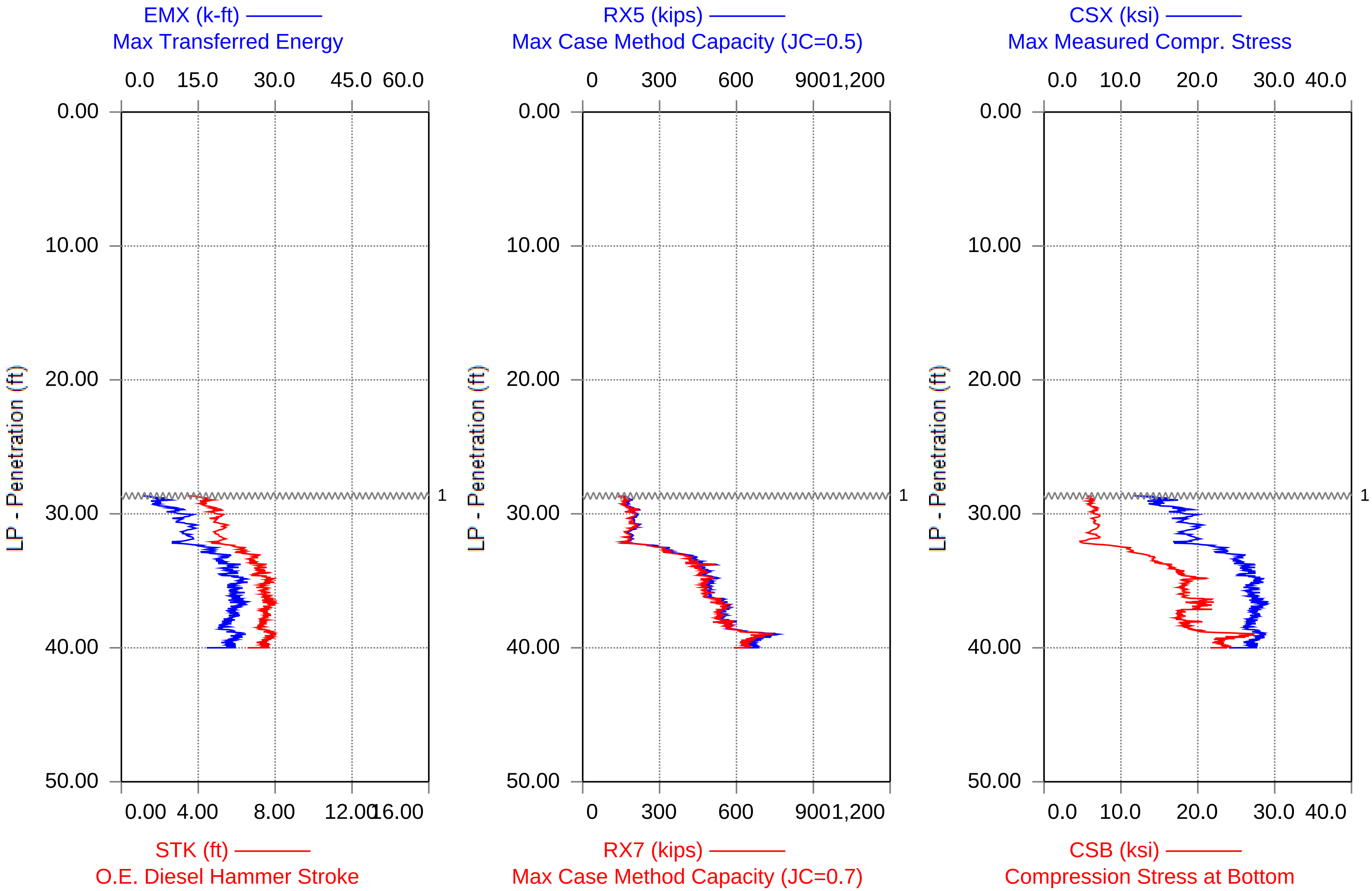
Figure 6. Signal Matching Model (i.e. CAPWAP® or TEPWAP/PWAP).

APPENDIX B
PDA VARIABLES

Geosciences Testing & Research Inc - PDIPLOT2 Ver 2016.1.56.1 - Case Method & iCAP® Results

Printed: 13-April-2016 Test started: 06-April-2016

Rutland - A2-22



1 - Hammer operating erratically prior to 29' penetration.

Rutland - A2-22
OP:
Date: 06-April-2016

AR:	30.00 in²	SP:	0.492 k/ft³
LE:	47.50 ft	EM:	30,000 ksi
WS:	16,810.0 f/s	JC:	0.50 []

EMX: Max Transferred Energy
STK: O.E. Diesel Hammer Stroke
RX5: Max Case Method Capacity (JC=0.5)
RX7: Max Case Method Capacity (JC=0.7)
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
DMX: Maximum Displacement
QUT: Energy formula (DFN)

BL#	Depth	BLC	TYPE	EMX	STK	RX5	RX7	CSX	CSB	DMX	QUT
	ft	**		k-ft	ft	kips	kips	ksi	ksi	in	kips
154	29	29	AV11	7.1	4.2	174	163	14.9	6.0	0.46	191
			MAX	9.7	4.8	194	185	17.4	6.5	0.56	237
			MIN	4.1	3.4	152	138	11.7	5.5	0.41	119
179	30	25	AV25	9.0	4.6	188	178	16.5	6.3	0.56	207
			MAX	12.3	5.2	221	216	19.3	7.0	0.68	255
			MIN	5.8	4.1	165	153	13.4	5.7	0.48	145
197	31	18	AV18	12.5	5.1	207	197	18.9	6.8	0.74	213
			MAX	14.7	5.5	224	216	20.6	7.2	0.81	241
			MIN	9.9	4.6	185	175	16.6	6.2	0.67	179
212	32	15	AV15	13.1	5.1	188	179	19.0	6.4	0.84	192
			MAX	14.5	5.4	205	192	20.3	7.3	0.87	211
			MIN	11.6	4.8	170	161	17.5	5.4	0.82	172
235	33	23	AV23	15.4	5.8	288	275	21.7	9.4	0.68	311
			MAX	19.1	6.6	394	375	24.5	12.8	0.78	386
			MIN	9.8	4.7	156	149	16.8	4.7	0.60	197
265	34	30	AV30	20.4	7.0	446	429	25.7	14.9	0.64	471
			MAX	23.3	7.6	524	509	27.5	16.8	0.69	520
			MIN	18.4	6.6	399	378	24.6	13.2	0.61	439
308	35	43	AV43	21.7	7.3	488	472	26.8	18.1	0.61	588
			MAX	24.5	7.9	528	508	28.5	21.1	0.66	645
			MIN	19.3	6.8	450	435	25.3	16.3	0.56	540
347	36	39	AV39	22.2	7.4	494	476	27.0	18.2	0.62	573
			MAX	24.6	7.9	515	494	28.5	19.0	0.65	616
			MIN	20.6	7.0	476	458	25.9	17.4	0.59	543
390	37	43	AV43	22.8	7.7	537	522	27.8	19.8	0.59	634
			MAX	24.7	8.0	577	566	29.1	22.1	0.63	678
			MIN	20.9	7.3	489	471	26.4	18.0	0.54	584
438	38	48	AV48	21.6	7.5	551	538	27.3	18.0	0.56	639
			MAX	23.1	7.8	577	568	28.1	21.9	0.60	684
			MIN	20.0	7.2	533	519	26.3	17.0	0.52	604
489	39	51	AV51	20.9	7.4	610	597	27.1	20.2	0.53	658
			MAX	24.3	8.1	763	730	28.8	27.3	0.56	744
			MIN	18.9	7.1	521	508	25.9	17.8	0.50	614
573	40	84	AV84	21.7	7.5	682	652	27.4	23.8	0.52	790
			MAX	23.8	8.0	762	734	28.9	27.1	0.54	841

Rutland - A2-22
OP:

Date: 06-April-2016

BL#	Depth	BLC	TYPE	EMX	STK	RX5	RX7	CSX	CSB	DMX	QUT
	ft	**		k-ft	ft	kips	kips	ksi	ksi	in	kips
			MIN	16.7	6.6	624	590	24.0	21.7	0.44	681
			Average	19.5	6.9	491	475	25.3	17.1	0.59	560
			Maximum	24.7	8.1	763	734	29.1	27.3	0.87	841
			Minimum	4.1	3.4	152	138	11.7	4.7	0.41	119

Total number of blows analyzed: 430

BL#	Sensors
144-573	F3: [] 91.5 (1.00); F4: [] 94.0 (1.00); A3: [] 380.0 (1.00); A4: [] 372.0 (1.00)

BL#	Comments
144	Hammer operating erratically prior to 29' penetration.

Time Summary

Drive	9 minutes 22 seconds	3:48 PM - 3:57 PM (4/6/2016) BN 1 - 10
Stop	10 minutes 13 seconds	3:57 PM - 4:07 PM
Drive	37 minutes 25 seconds	4:07 PM - 4:45 PM BN 11 - 50
Stop	25 minutes 3 seconds	4:45 PM - 5:10 PM
Drive	31 minutes 12 seconds	5:10 PM - 5:41 PM BN 51 - 138
Stop	27 minutes 3 seconds	5:41 PM - 6:08 PM
Drive	11 minutes 25 seconds	6:08 PM - 6:19 PM BN 139 - 573

Total time [02:31:43] = (Driving [01:29:24] + Stop [01:02:19])

Rutland - A2-22
OP: Date: 06-April-2016

AR: 30.00 in² SP: 0.492 k/ft³
LE: 47.50 ft EM: 30,000 ksi
WS: 16,810.0 f/s JC: 0.50 []

EMX: Max Transferred Energy
STK: O.E. Diesel Hammer Stroke
RX5: Max Case Method Capacity (JC=0.5)
RX7: Max Case Method Capacity (JC=0.7)
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
DMX: Maximum Displacement
QUT: Energy formula (DFN)

BL#	Depth	BLC	EMX	STK	RX5	RX7	CSX	CSB	DMX	QUT
	ft	**	k-ft	ft	kips	kips	ksi	ksi	in	kips
237	33	30	21.3	7.2	413	395	26.1	13.4	0.69	471
239	33	30	20.5	7.1	417	400	25.8	13.7	0.67	464
241	33	30	19.9	6.9	443	425	25.6	14.3	0.64	462
243	33	30	20.6	7.1	444	425	25.8	14.4	0.65	474
245	33	30	18.8	6.7	412	401	24.9	14.2	0.61	446
247	33	30	19.0	6.7	441	425	24.9	14.2	0.62	448
249	33	30	19.8	6.9	436	416	25.4	14.3	0.64	462
251	34	30	19.7	6.9	465	451	25.5	14.7	0.63	460
253	34	30	19.5	6.8	469	453	25.3	15.0	0.62	459
255	34	30	20.7	7.1	449	427	26.0	14.9	0.64	477
257	34	30	20.9	7.1	477	460	26.1	15.4	0.64	484
259	34	30	22.8	7.5	524	509	27.4	16.6	0.66	517
261	34	30	20.6	7.1	447	433	25.9	16.2	0.63	481
263	34	30	21.2	7.2	447	428	26.0	16.4	0.64	488
265	34	30	22.9	7.6	479	465	27.5	16.8	0.66	519
		Average	20.4	7.0	446	429	25.7	14.9	0.64	471

Total number of blows analyzed: 30

BL# Sensors

144-573 F3: [] 91.5 (1.00); F4: [] 94.0 (1.00); A3: [] 380.0 (1.00); A4: [] 372.0 (1.00)

BL# Comments

144 Hammer operating erratically prior to 29' penetration.

Time Summary

Drive 9 minutes 22 seconds 3:48 PM - 3:57 PM (4/6/2016) BN 1 - 10
Stop 10 minutes 13 seconds 3:57 PM - 4:07 PM
Drive 37 minutes 25 seconds 4:07 PM - 4:45 PM BN 11 - 50
Stop 25 minutes 3 seconds 4:45 PM - 5:10 PM
Drive 31 minutes 12 seconds 5:10 PM - 5:41 PM BN 51 - 138
Stop 27 minutes 3 seconds 5:41 PM - 6:08 PM
Drive 11 minutes 25 seconds 6:08 PM - 6:19 PM BN 139 - 573

Total time [02:31:43] = (Driving [01:29:24] + Stop [01:02:19])

Rutland - A2-22
OP: Date: 06-April-2016

AR: 30.00 in² SP: 0.492 k/ft³
LE: 47.50 ft EM: 30,000 ksi
WS: 16,810.0 f/s JC: 0.50 []

EMX: Max Transferred Energy
STK: O.E. Diesel Hammer Stroke
RX5: Max Case Method Capacity (JC=0.5)
RX7: Max Case Method Capacity (JC=0.7)
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
DMX: Maximum Displacement
QUT: Energy formula (DFN)

BL#	Depth	BLC	EMX	STK	RX5	RX7	CSX	CSB	DMX	QUT
	ft	**	k-ft	ft	kips	kips	ksi	ksi	in	kips
492	39	84	22.8	7.8	751	718	28.2	27.0	0.53	815
495	39	84	22.1	7.7	715	686	27.9	25.3	0.52	801
498	39	84	21.3	7.5	712	684	27.3	25.7	0.51	782
501	39	84	22.3	7.7	724	696	28.0	25.5	0.53	805
504	39	84	22.7	7.7	692	668	28.0	23.6	0.53	811
507	39	84	22.9	7.8	685	665	28.3	23.8	0.54	815
510	39	84	22.1	7.6	684	655	27.7	24.5	0.53	786
513	39	84	22.5	7.8	673	651	28.1	22.3	0.53	814
516	39	84	22.2	7.7	673	654	27.8	22.9	0.53	801
519	39	84	22.5	7.8	661	636	28.1	22.1	0.52	818
522	39	84	22.0	7.7	684	657	27.7	22.7	0.52	798
525	39	84	20.7	7.3	650	619	26.9	22.7	0.50	768
528	39	84	21.9	7.6	685	656	27.5	23.5	0.52	797
531	40	84	20.7	7.3	667	635	26.8	22.7	0.51	762
534	40	84	20.8	7.3	668	636	26.8	23.0	0.51	760
537	40	84	20.3	7.2	656	624	26.4	22.4	0.50	758
540	40	84	19.5	7.0	644	614	26.0	21.9	0.48	747
543	40	84	21.1	7.4	671	638	27.0	22.9	0.51	775
546	40	84	21.0	7.4	662	634	27.3	22.8	0.50	783
549	40	84	21.4	7.5	659	630	27.2	22.7	0.51	790
552	40	84	21.1	7.4	654	622	26.9	23.0	0.51	771
555	40	84	21.4	7.5	675	643	27.2	23.7	0.51	785
558	40	84	21.3	7.4	672	639	27.0	23.4	0.51	781
561	40	84	20.8	7.4	663	631	26.6	23.1	0.51	766
564	40	84	22.3	7.6	688	656	27.5	24.3	0.52	802
567	40	84	20.5	7.4	673	646	26.7	23.5	0.49	784
570	40	84	21.8	7.6	676	645	27.2	23.8	0.52	792
573	40	84	16.7	6.6	624	590	24.0	21.7	0.44	681
		Average	21.7	7.5	682	652	27.4	23.8	0.52	790

Total number of blows analyzed: 84

BL# Sensors

144-573 F3: [] 91.5 (1.00); F4: [] 94.0 (1.00); A3: [] 380.0 (1.00); A4: [] 372.0 (1.00)

BL# Comments

144 Hammer operating erratically prior to 29' penetration.

Time Summary

Drive 9 minutes 22 seconds 3:48 PM - 3:57 PM (4/6/2016) BN 1 - 10
Stop 10 minutes 13 seconds 3:57 PM - 4:07 PM
Drive 37 minutes 25 seconds 4:07 PM - 4:45 PM BN 11 - 50
Stop 25 minutes 3 seconds 4:45 PM - 5:10 PM

Rutland - A2-22
OP:
Date: 06-April-2016

Drive	31 minutes 12 seconds	5:10 PM - 5:41 PM BN 51 - 138
Stop	27 minutes 3 seconds	5:41 PM - 6:08 PM
Drive	11 minutes 25 seconds	6:08 PM - 6:19 PM BN 139 - 573

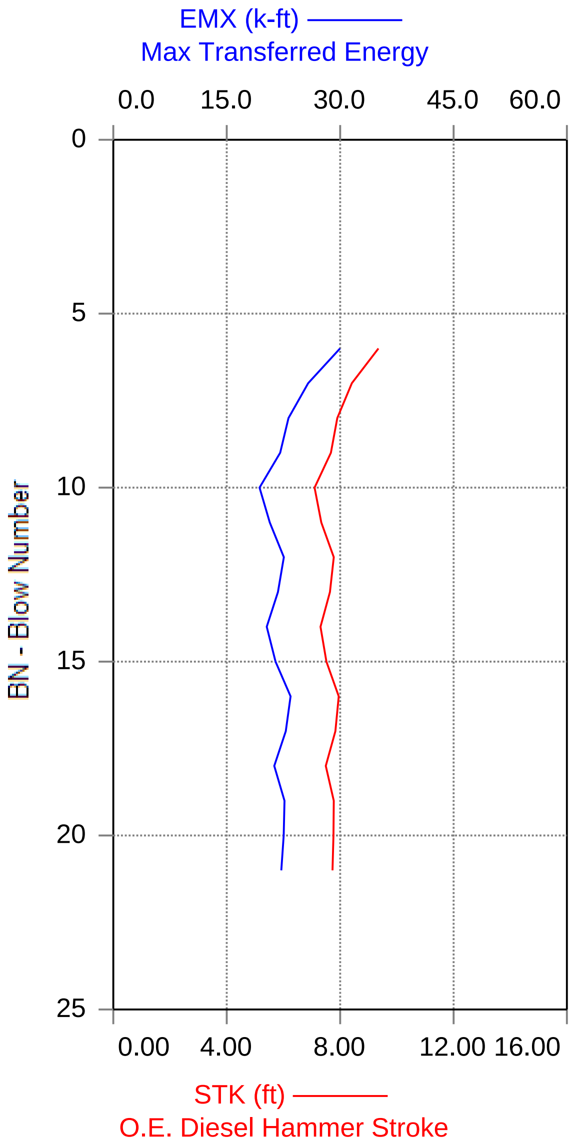
Total time [02:31:43] = (Driving [01:29:24] + Stop [01:02:19])

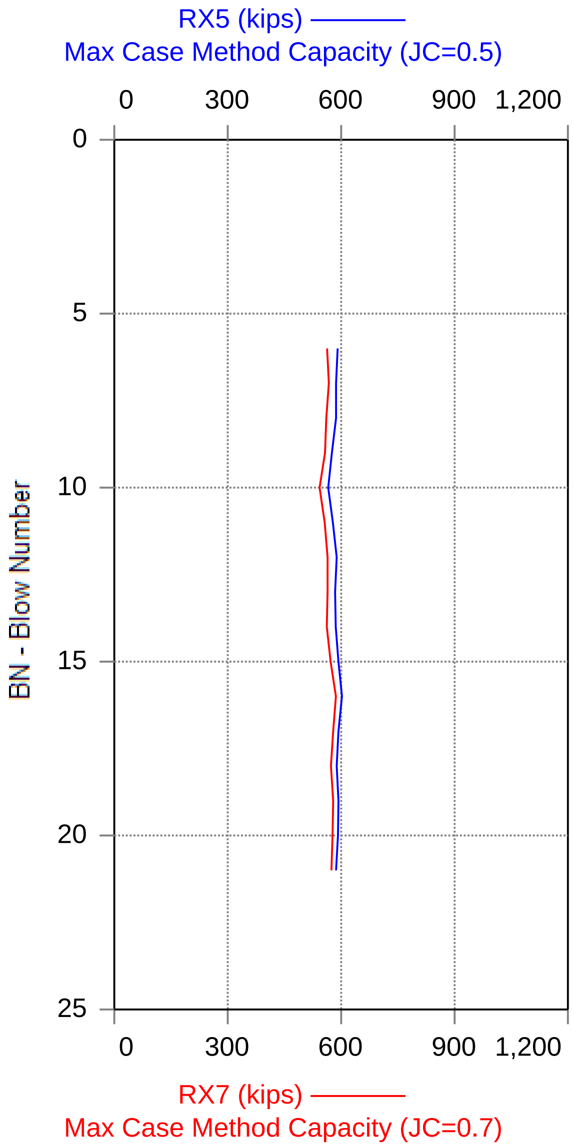
Geosciences Testing & Research Inc - PDIPLOT2 Ver 2016.1.56.1 - Case Method & iCAP® Results

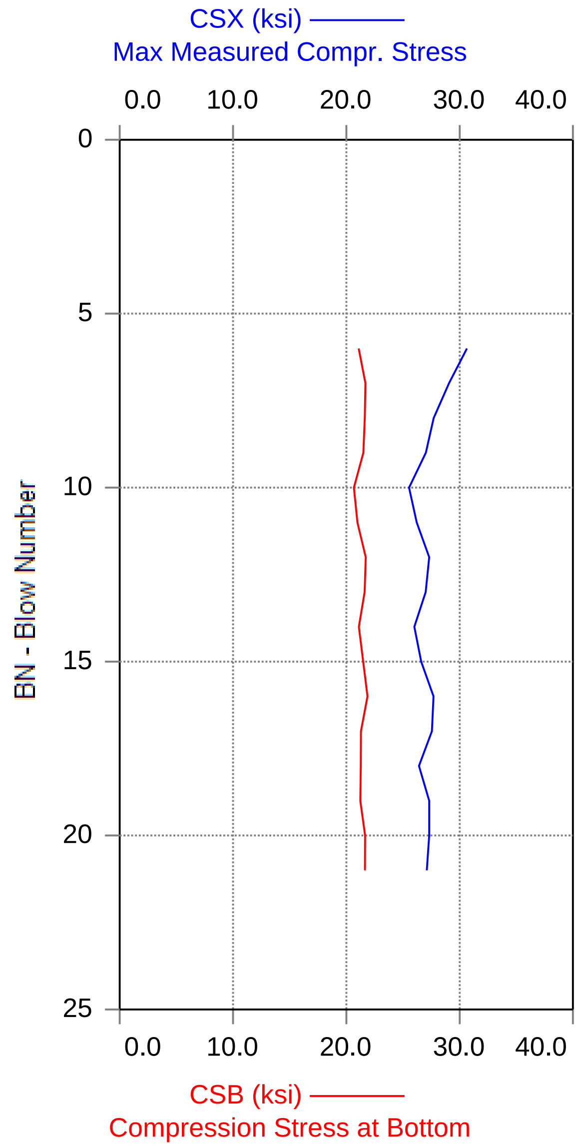
Printed: 13-April-2016

Test started: 11-April-2016

Rutland - A2-22BOR







Rutland - A2-22BOR
OP:

Date: 11-April-2016

AR: 30.00 in²
LE: 47.50 ft
WS: 16,810.0 f/s

SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.50 []

EMX: Max Transferred Energy
STK: O.E. Diesel Hammer Stroke
RX5: Max Case Method Capacity (JC=0.5)
RX7: Max Case Method Capacity (JC=0.7)

CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom
DMX: Maximum Displacement
QUT: Energy formula (DFN)

BL#	Depth	BLC	EMX	STK	RX5	RX7	CSX	CSB	DMX	QUT
	ft	**	k-ft	ft	kips	kips	ksi	ksi	in	kips
6	40	0	30.0	9.3	591	563	30.6	21.1	0.65	741
7	40	0	25.8	8.4	586	567	29.1	21.7	0.59	740
8	40	0	23.2	7.9	587	561	27.7	21.6	0.54	736
9	40	0	22.1	7.7	576	557	27.0	21.5	0.53	716
10	40	0	19.3	7.1	566	543	25.5	20.7	0.49	701
11	40	0	20.7	7.3	578	557	26.2	21.0	0.52	700
12	40	0	22.6	7.8	588	564	27.3	21.7	0.55	706
13	40	0	21.8	7.6	584	564	27.0	21.6	0.54	709
14	40	0	20.3	7.3	586	562	26.0	21.1	0.51	703
15	40	0	21.4	7.5	593	572	26.6	21.5	0.53	715
16	40	0	23.4	7.9	602	586	27.7	21.9	0.56	722
17	40	0	22.8	7.8	593	579	27.5	21.3	0.55	729
18	40	0	21.3	7.5	588	573	26.4	21.3	0.54	698
19	40	0	22.6	7.8	593	579	27.3	21.2	0.56	708
20	40	0	22.5	7.8	592	577	27.3	21.7	0.55	712
21	40	0	22.2	7.7	586	574	27.1	21.6	0.56	705
		Average	22.6	7.8	587	567	27.3	21.4	0.55	715

Total number of blows analyzed: 16

BL# Sensors

6-21 F3: [] 91.5 (1.00); F4: [] 94.0 (1.00); A3: [] 380.0 (1.00); A4: [] 372.0 (1.00)

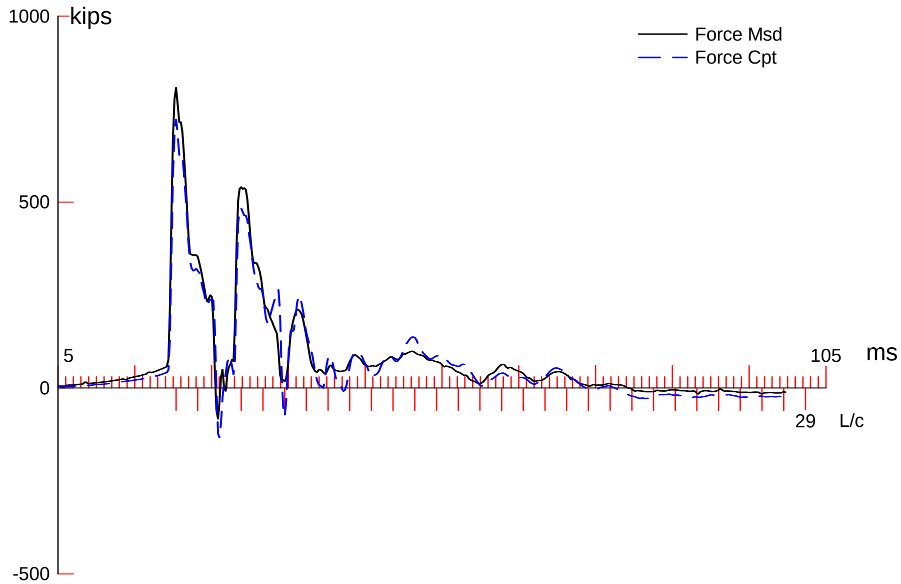
Time Summary

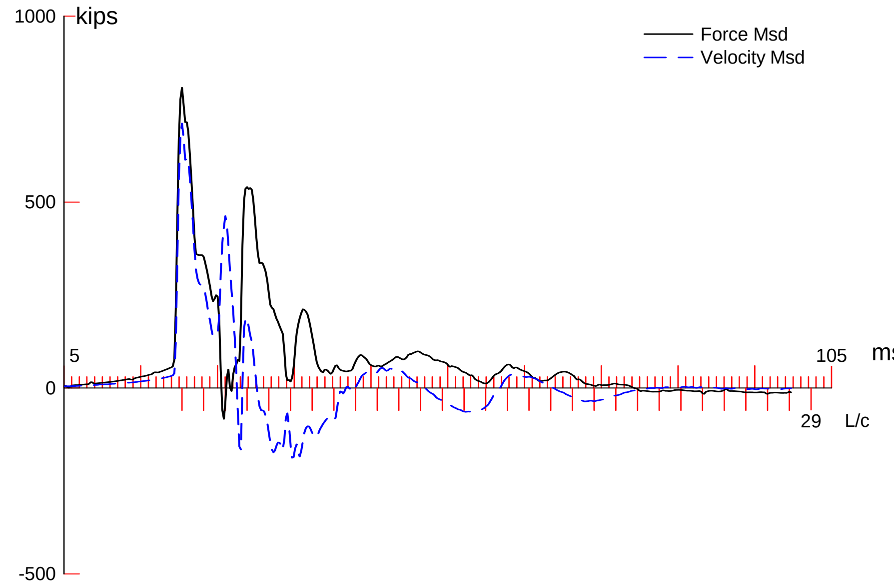
Drive 24 seconds 10:01 AM - 10:02 AM BN 5 - 22

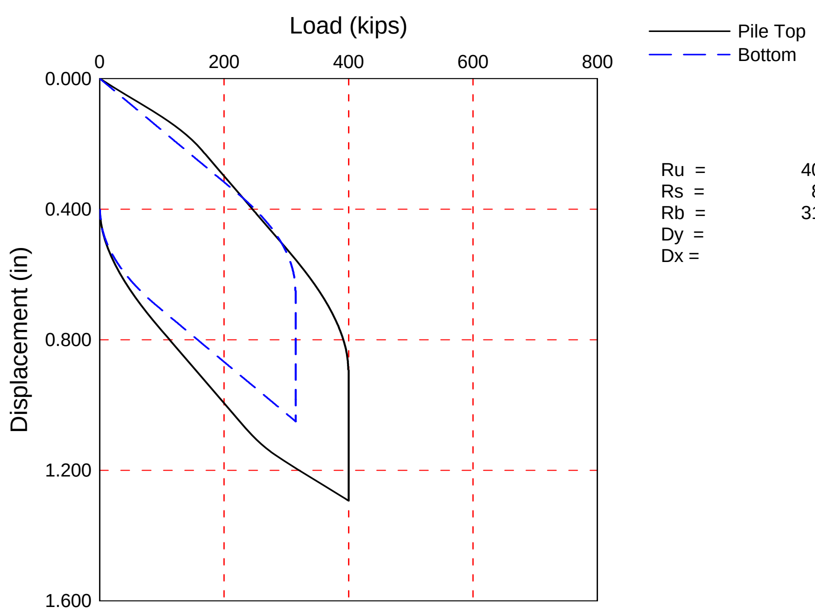
APPENDIX C
CAPWAP RESULTS

Rutland; Pile: A2-22; Blow: 258 (Test: 06-Apr-2016 18:12:)
Geosciences Testing & Research Inc

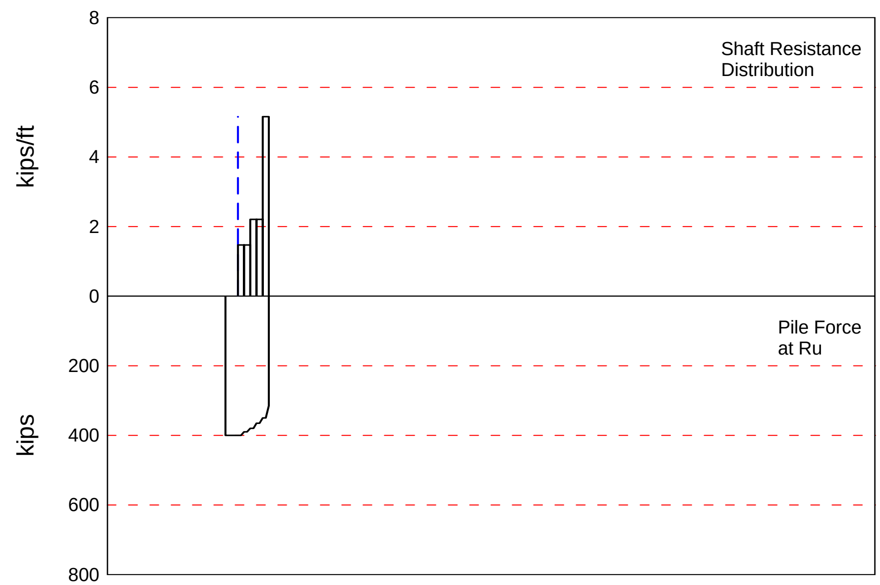
13-Apr-2016
CAPWAP(R) 2006-3







Ru =	400.0	kips
Rs =	85.0	kips
Rb =	315.0	kips
Dy =	0.89	in
Dx =	1.29	in



CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 400.0; along Shaft 85.0; at Toe 315.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				400.0				
1	20.4	6.6	10.0	390.0	10.0	1.51	0.72	0.150
2	27.1	13.4	10.0	380.0	20.0	1.47	0.70	0.150
3	33.9	20.2	15.0	365.0	35.0	2.21	1.06	0.150
4	40.7	27.0	15.0	350.0	50.0	2.21	1.06	0.150
5	47.5	33.8	35.0	315.0	85.0	5.16	2.46	0.150
Avg. Shaft			17.0			2.52	1.20	0.150
Toe			315.0				902.41	0.060

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.100	0.500
Case Damping Factor		0.238	0.353
Damping Type			Smith
Unloading Quake	(% of loading quake)	30	30
Reloading Level	(% of Ru)	100	100
Resistance Gap (included in Toe Quake) (in)			0.050

CAPWAP match quality = 3.50 (Force Match) ; RSA = 0
Observed: final set = 0.400 in; blow count = 30 b/ft
Computed: final set = 0.394 in; blow count = 30 b/ft

max. Top Comp. Stress = 24.1 ksi (T= 20.6 ms, max= 1.011 x Top)
max. Comp. Stress = 24.3 ksi (Z= 20.4 ft, T= 21.8 ms)
max. Tens. Stress = -4.43 ksi (Z= 3.4 ft, T= 26.2 ms)
max. Energy (EMX) = 20.0 kip-ft; max. Measured Top Displ. (DMX)= 0.70 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	722.0	-132.9	24.1	-4.43	20.04	13.3	0.687
2	6.8	721.6	-86.8	24.0	-2.89	20.09	13.2	0.670
3	10.2	720.7	-107.6	24.0	-3.59	19.83	13.2	0.654
4	13.6	720.6	-117.5	24.0	-3.91	19.54	13.2	0.637
5	17.0	725.6	-79.4	24.2	-2.65	19.26	13.0	0.621
6	20.4	729.7	-43.0	24.3	-1.43	18.99	12.9	0.604
7	23.8	705.3	-33.2	23.5	-1.11	17.65	12.7	0.588
8	27.1	709.8	-33.7	23.7	-1.12	17.33	12.6	0.575
9	30.5	688.1	-34.1	22.9	-1.14	16.16	12.4	0.566
10	33.9	694.0	-29.3	23.1	-0.98	16.05	14.5	0.557
11	37.3	658.2	-19.6	21.9	-0.65	14.34	16.6	0.547
12	40.7	621.5	-27.8	20.7	-0.93	14.16	17.4	0.534
13	44.1	433.5	0.0	14.4	0.00	12.32	18.6	0.520
14	47.5	418.7	0.0	14.0	0.00	9.28	18.7	0.505
Absolute	20.4			24.3			(T =	21.8 ms)
	3.4				-4.43		(T =	26.2 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	536.2	436.2	336.3	236.3	136.3	36.3	0.0	0.0	0.0	0.0
RX	566.7	558.0	549.3	540.5	531.8	523.1	514.4	505.6	496.9	488.2
RU	536.2	436.2	336.3	236.3	136.3	36.3	0.0	0.0	0.0	0.0

RAU = 383.7 (kips); RA2 = 479.8 (kips)

Current CAPWAP Ru = 400.0 (kips); Corresponding J(RP)= 0.14;

RMX requires higher damping; see PDA-W

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS
ft/s	ms	kips	kips	kips	in	in	in	kip-ft	kips
13.42	20.59	718.8	817.2	821.1	0.704	0.387	0.400	23.5	511.3

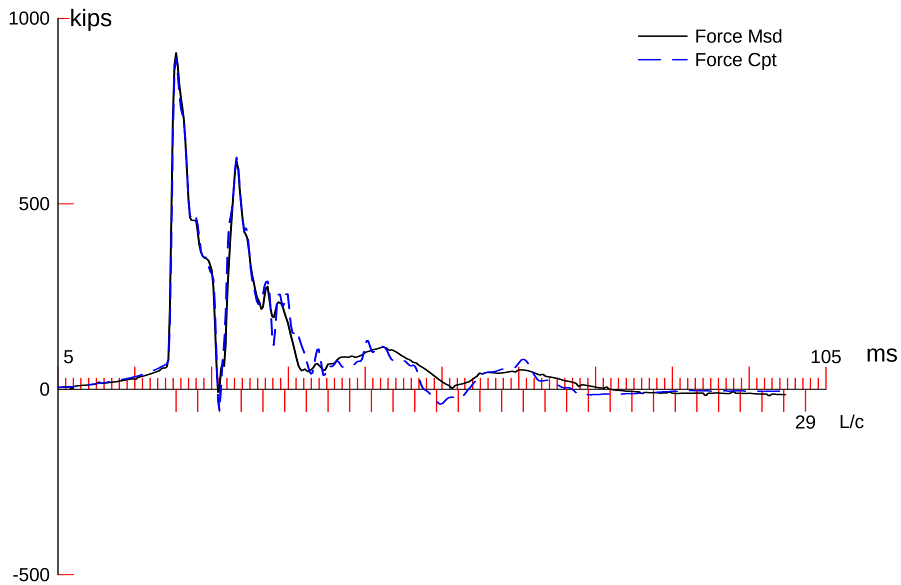
PILE PROFILE AND PILE MODEL

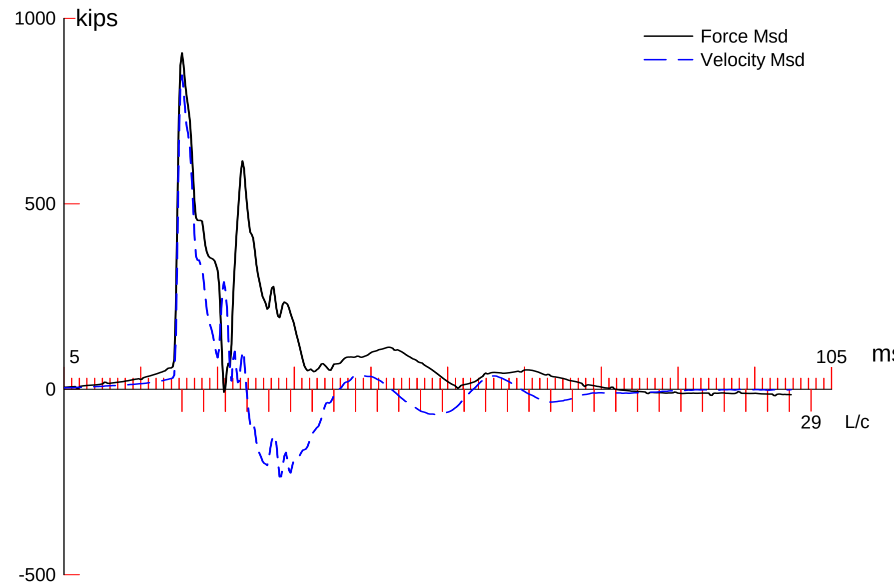
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	30.00	29999.9	492.000	2.094
47.50	30.00	29999.9	492.000	2.094

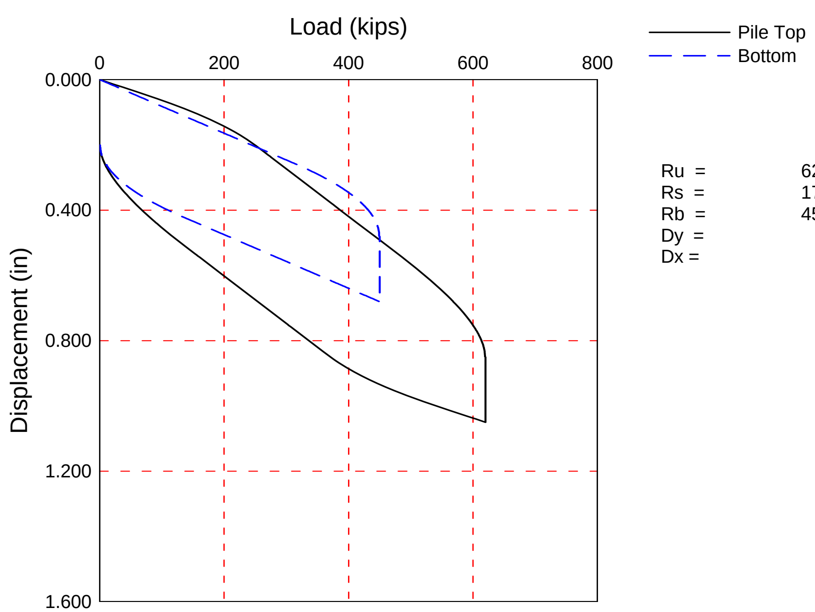
Toe Area 0.349 ft^2

Top Segment Length 3.39 ft, Top Impedance 53.55 kips/ft/s

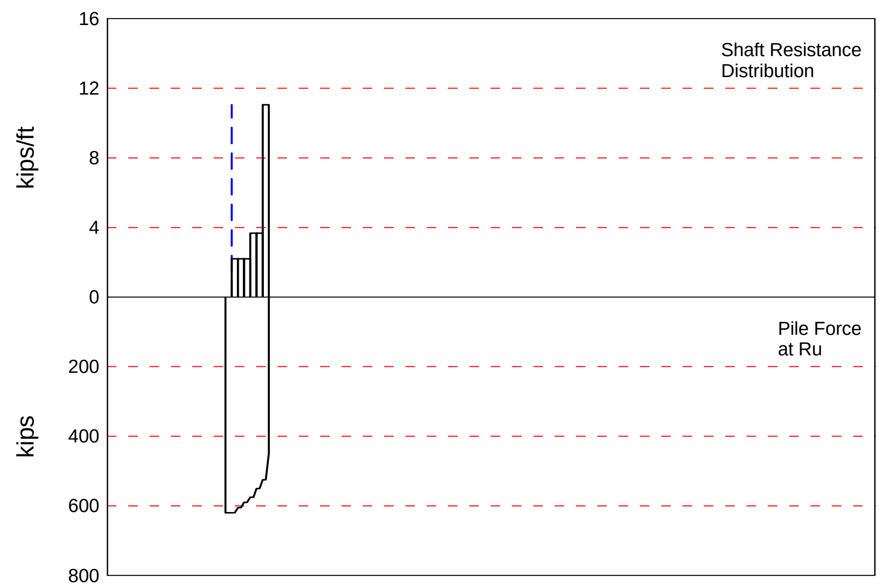
Pile Damping 3.0 %, Time Incr 0.202 ms, Wave Speed 16810.0 ft/s, 2L/c 5.7 ms







Ru =	620.0	kips
Rs =	170.0	kips
Rb =	450.0	kips
Dy =	0.85	in
Dx =	1.05	in



CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 620.0; along Shaft 170.0; at Toe 450.0 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				620.0				
1	13.6	6.1	15.0	605.0	15.0	2.47	1.18	0.150
2	20.4	12.9	15.0	590.0	30.0	2.21	1.06	0.150
3	27.1	19.6	15.0	575.0	45.0	2.21	1.06	0.150
4	33.9	26.4	25.0	550.0	70.0	3.68	1.76	0.150
5	40.7	33.2	25.0	525.0	95.0	3.68	1.76	0.150
6	47.5	40.0	75.0	450.0	170.0	11.05	5.28	0.150
Avg. Shaft			28.3			4.25	2.03	0.150
Toe			450.0				1289.15	0.050

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.050	0.370
Case Damping Factor		0.476	0.420
Damping Type			Smith
Unloading Quake	(% of loading quake)	20	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	2	
Resistance Gap (included in Toe Quake) (in)			0.050

CAPWAP match quality = 2.46 (Force Match) ; RSA = 0
Observed: final set = 0.200 in; blow count = 60 b/ft
Computed: final set = 0.190 in; blow count = 63 b/ft

max. Top Comp. Stress = 29.7 ksi (T= 20.6 ms, max= 1.025 x Top)
max. Comp. Stress = 30.5 ksi (Z= 13.6 ft, T= 21.4 ms)
max. Tens. Stress = -1.92 ksi (Z= 3.4 ft, T= 26.2 ms)
max. Energy (EMX) = 28.2 kip-ft; max. Measured Top Displ. (DMX)= 0.66 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	892.5	-57.7	29.7	-1.92	28.17	15.8	0.632
2	6.8	896.3	-37.9	29.9	-1.26	27.96	15.7	0.610
3	10.2	908.4	-37.8	30.3	-1.26	27.58	15.4	0.600
4	13.6	914.9	-44.2	30.5	-1.47	27.36	15.3	0.585
5	17.0	877.1	-47.4	29.2	-1.58	25.39	15.0	0.568
6	20.4	884.2	-50.3	29.5	-1.68	25.07	14.8	0.550
7	23.8	846.6	-49.5	28.2	-1.65	23.16	14.5	0.532
8	27.1	854.9	-49.9	28.5	-1.66	22.78	14.3	0.512
9	30.5	823.9	-46.2	27.5	-1.54	20.84	14.0	0.491
10	33.9	836.7	-45.6	27.9	-1.52	20.38	14.1	0.469
11	37.3	775.8	-40.9	25.9	-1.36	17.49	16.3	0.446
12	40.7	751.5	-40.1	25.0	-1.34	16.97	17.3	0.423
13	44.1	555.2	-35.2	18.5	-1.17	14.15	19.0	0.399
14	47.5	645.2	-34.5	21.5	-1.15	8.55	18.5	0.375
Absolute	13.6			30.5			(T =	21.4 ms)
	3.4				-1.92		(T =	26.2 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	757.5	654.9	552.3	449.7	347.1	244.6	142.0	39.4	0.0	0.0
RX	793.2	729.5	670.7	642.9	619.2	602.3	589.3	576.4	563.4	550.4
RU	757.5	654.9	552.3	449.7	347.1	244.6	142.0	39.4	0.0	0.0

RAU = 455.9 (kips); RA2 = 647.4 (kips)

Current CAPWAP Ru = 620.0 (kips); Corresponding J(RP)= 0.13; J(RX) = 0.40

VMX ft/s	TVP ms	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
16.13	20.59	863.9	919.4	919.4	0.656	0.188	0.200	29.7	832.1

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	30.00	29999.9	492.000	2.094
47.50	30.00	29999.9	492.000	2.094

Toe Area 0.349 ft^2

Top Segment Length 3.39 ft, Top Impedance 53.55 kips/ft/s

Pile Damping 3.0 %, Time Incr 0.202 ms, Wave Speed 16810.0 ft/s, 2L/c 5.7 ms